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TITLE: Method and apparatus for analyzing and monitoring packet streams

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US Patent No. - PN (1):
6233256

Parent Case Text - PCTX (2):
The present invention relates to an apparatus and concomitant method for analyzing and monitoring packet streams in a communication system. More particularly, this invention relates to a method and apparatus that evaluates transport packet streams in "real **time**" for detecting errors, verifying the consistency of **time base** information and displaying important packet stream information.

Brief Summary Text - BSTX (5):
Thus, in order to monitor and evaluate the status of a transport stream in real time, a method or apparatus must be able to handle the high transfer rate of the transmission channel. To illustrate, if data from the transport stream is arriving at a rate of 5 Mega-bytes per second and a processing unit operates at 20 Mega-instructions per second, then the processing unit must perform, on average, a READ operation every fourth instruction. This requirement is computationally expensive and increases the cost of performing real time packet analysis. In fact, since time is such a scarce resource in real time packet analysis, it may become prohibitively expensive. Although it may be more cost effective to capture the data in the transport stream into storage and then analyze the data at a later time, the benefit of real time analysis is lost. These benefits may include the detection of packet framing errors, jitters, inconsistent **time base** information or network wide errors that may affect a plurality of channels.

Brief Summary Text - BSTX (6):

Therefore, a need exists in the art for a method and apparatus for performing real time packet analysis without the associated high computational expense. Specifically, a need exists for a method and apparatus for detecting errors, verifying the consistencies of **time base** information and displaying important packet stream information.

Brief Summary Text - BSTX (10):

The present invention also minimizes the number of bytes that are processed by the real-time analysis unit by implementing a "flushing" circuit and method. This flushing method distinguishes payload carrying scrambled data in video and
audio packets from those packets carrying important control data such as adaptation information relating to **time base**. Since the access of scrambled data is often limited, they provide little information in packet analysis except for the fact that a packet of this type has been transmitted and received. As such, the data bytes in such packets are flushed from the input buffer, thereby reducing significantly the number of bytes of data that the real-time analysis unit must process.

Brief Summary Text - BSTX (11):

Furthermore, the present invention incorporates a plurality of methods in verifying the consistency of **time base** information. Specifically, the difference in program clock reference (PCR) values, the bit **rate** between PCR values and the difference in the arrival time of the PCR values are compared in different combinations with each other to determine the degree of PCR **jitter** in the packet stream.

Drawing Description Text - DRTX (7):

FIG. 5 illustrates a flowchart of a method for verifying the consistency of **time base** information in a transport stream;

Drawing Description Text - DRTX (8):

FIG. 6 illustrates a flowchart of a second method for verifying the consistency of **time base** information in a transport stream;

Drawing Description Text - DRTX (9):

FIG. 7 illustrates a flowchart of a third method for verifying the

consistency of **time base** information in a transport stream;

Detailed Description Text - DETX (5):
The packets are received and multiplexed by the transport stream multiplexor 140 to produce a transport stream 145. Packets constructed from elementary streams that form a program (a group of "Packet Identifiers" (PIDs) with associated video and audio data) generally share a common **time base**. Thus, the
transport stream may contain one or more programs with one or more independent
time bases, where the time bases are used for synchronized presentation. The
time bases of different programs within a transport stream may be different.

Detailed Description Text - DETX (27):
The flushing method must distinguish payload carrying scrambled data in video and audio packets from those packets carrying important control data such as adaptation information relating to **time base**. Specifically, the control stream, "Program Association Table" (PAT), contains the important information on the location of other control streams in the form of "Packet Identifier" (PID) values. A PID is a unique 13 bit field, indicating the type of data that is stored in the packet payload. The PID values of 0 and 1 are reserved for the PAT and the "Conditional Access Table" (CAT) respectively.

Detailed Description Text - DETX (28):
Another important control stream is the "Program Map Tables" (PMT), which contains a list of PIDs and defines whether a PID carries video, audio, or "other data" in its payload. Thus, in order to determine the content of a packet payload, the PAT and PMT must be decoded before a packet stream's PID
can be determined. Since PID values do not change very often, the PAT is sent at a low data rate and successive transmissions of the PAT typically contain identical data. Thus, once a PID is determined, it can be used repeatedly to determine the payloads of its packets, thereby permitting the RAU to flush various payloads from the FIFO to conserve precious CPU cycles. Since both the
RAU and the User Unit incorporate some storage media, e.g., RAM or disk drives,
both unit will maintain various tables to track packet information, e.g., PID values, number of received packets and/or **time base** information as they are

received.

Detailed Description Text - DETX (33):

If the method 400 determines from the PID value that a packet is a video packet with adaptation data in step 430, then the packet is sent to step 450 where the adaptation header is read into the memory of the RAU. Video packets with adaptation fields are processed by reading the adaptation field where the first byte will define how many bytes must be read to obtain the adaptation data. Adaptation data is important because it often contains **time base** information such as Program Clock Reference (PCR). Again, the adaptation data
is forwarded to the User Unit for evaluating the transport stream, but the remaining portion of the packet is then flushed from the FIFO and a counter for tracking the reception of this particular PID is also incremented to record its reception in step 490.

Detailed Description Text - DETX (38):

FIG. 5 illustrates a method 500 for verifying the consistency of **time base** information in a transport stream. A transport stream may have a number of programs with each having a separate **time base** "clock". This creates the problem of measuring and verifying the consistency of the clocks on each of the programs. Each PID may contain adaptation sections for carrying PCR values, which are different from those of other PIDs. The MPEG standards require PCRs
to advance with limited amount of jitter, since **time base** information is used by the decoder to maintain synchronization with the encoder. The **time base** information must be very accurate down to 500 nano-seconds.

Detailed Description Text - DETX (42):

In step 560, the method 500 computes the transport **rate jitter** by obtaining a discrepancy between net number of bits calculated in steps 530 and 550. The method then ends in step 570.

Detailed Description Text - DETX (43):

In effect, method 500 compares two values: the number of packets (and therefore the number of bits) since the last PCR, and the product of the bitrate times the difference between the last PCR and the current PCR. If the **time base** information is correct, then the product should match the number of bits, where the discrepancy is the jitter or error. Once the transport **rate**

jitter is calculated, the **jitter** can be compared with a limit, added into an average, included into a histogram data file or sent to the User Unit for storage or display.

Detailed Description Text - DETX (44):

FIG. 6 illustrates a second method 600 for verifying the consistency of **time base** information in a transport stream. In this second method, a detector circuit is employed to record when a certain part of an incoming packet is present in the input to the FIFO 220. To illustrate, the detector should be able to detect the arrival of the 11th byte of a packet, which corresponds to the least significant bit of the program_clock_reference_base field. The detector should then simultaneously cause a counter value to be stored in a queue of Recorded PCR Values. The counter is clocked at a constant rate such that its value indicates time. In this fashion, it is not necessary to read the PCR values, but instead, the method places a "timestamp" associated with the packet in a queue.

Detailed Description Text - DETX (47):

In step 660, the method 600 computes the transport **rate jitter** by obtaining a discrepancy between net number of bits calculated in steps 630 and 650. The method then ends in step 670.

Detailed Description Text - DETX (49):

FIG. 7 illustrates a third method 700 for verifying the consistency of **time base** information in a transport stream. Referring to FIG. 7, the method 700 begins at step 710 and proceeds to step 720, where the method computes the difference between the current recorded PCR value with the last recorded PCR value. In step 730, the method computes the difference between the current PCR
value with the last PCR value.

Detailed Description Text - DETX (50):

In step 740, the method 700 computes the transport **rate jitter** by obtaining a discrepancy between the time calculated in steps 720 and 730. The method then ends in step 750.

Detailed Description Text - DETX (57):

There has thus been shown and described a novel method and apparatus for

evaluating transport packet streams in "real **time**" for detecting errors, verifying the consistency of **time base** information and displaying important packet stream information. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification and the accompanying drawings which disclose the embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is to be limited only by the claims which follow.

Claims Text - CLTX (13):

a storage medium, coupled to said first analysis unit, for storing a plurality of **time base** information for said plurality of packets for detecting transport **rate jitter**.